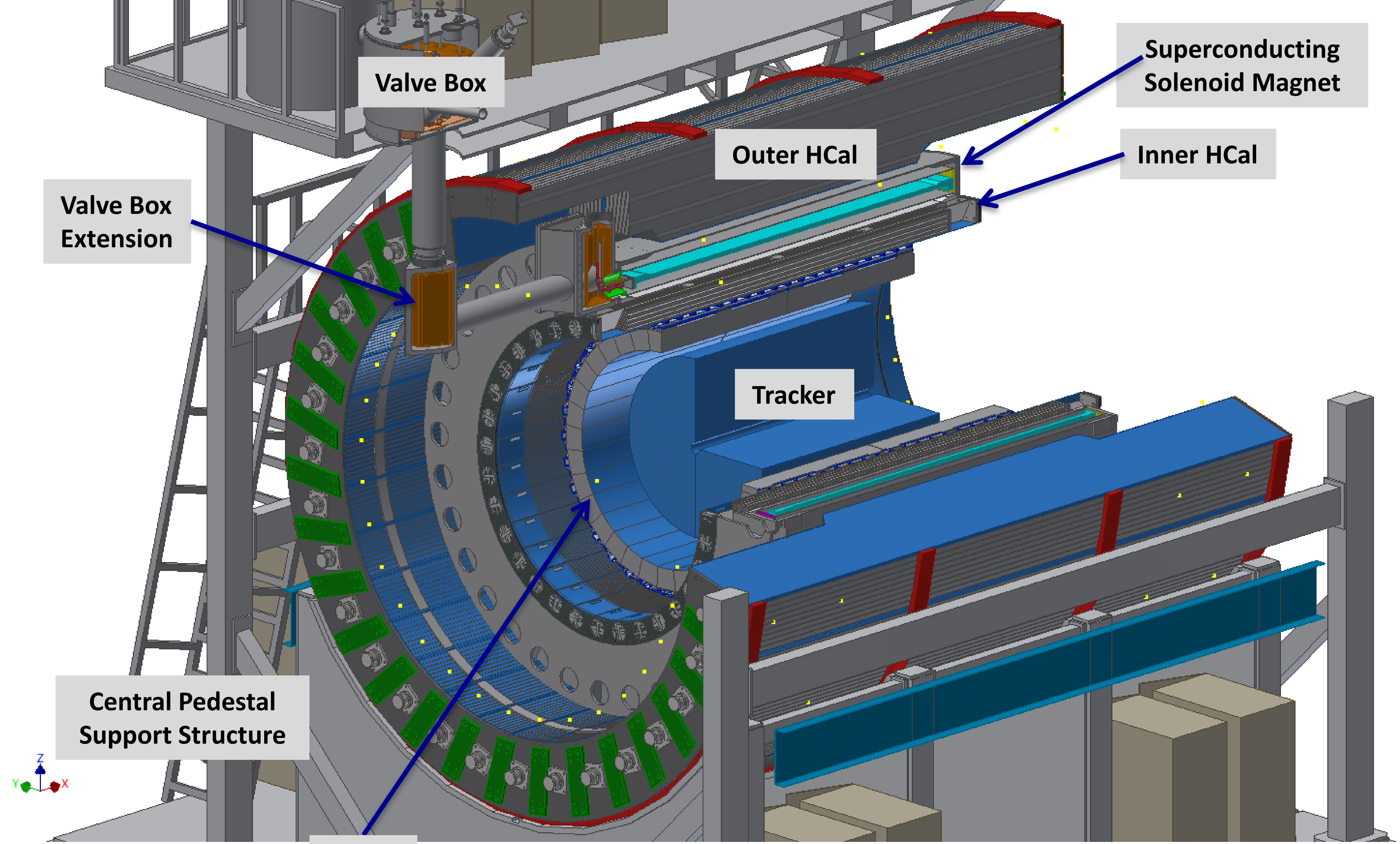


sPHENIX Calorimeters

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

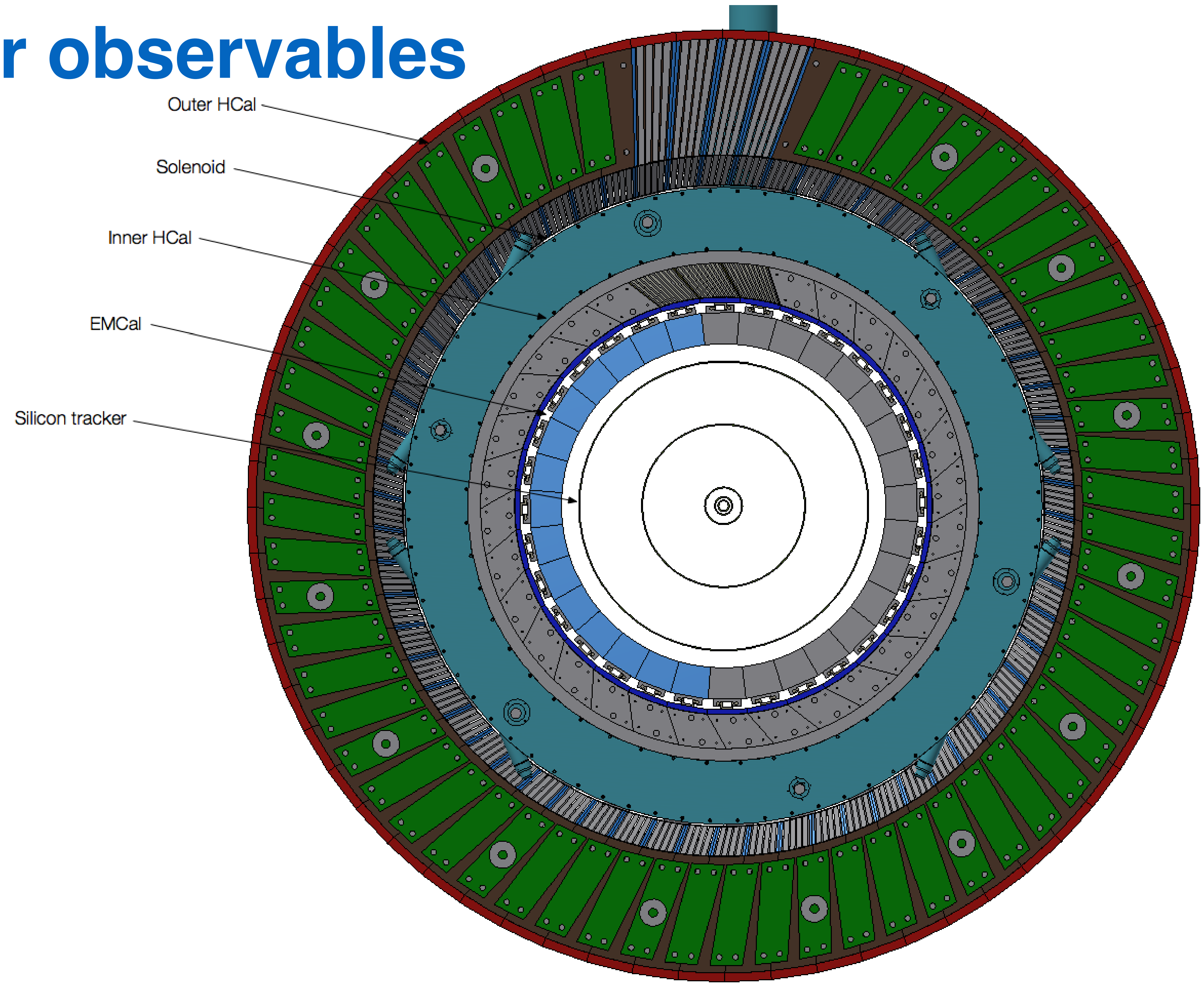
Anne M. Sickles

December 10, 2015

sPHENIX Calorimeter System

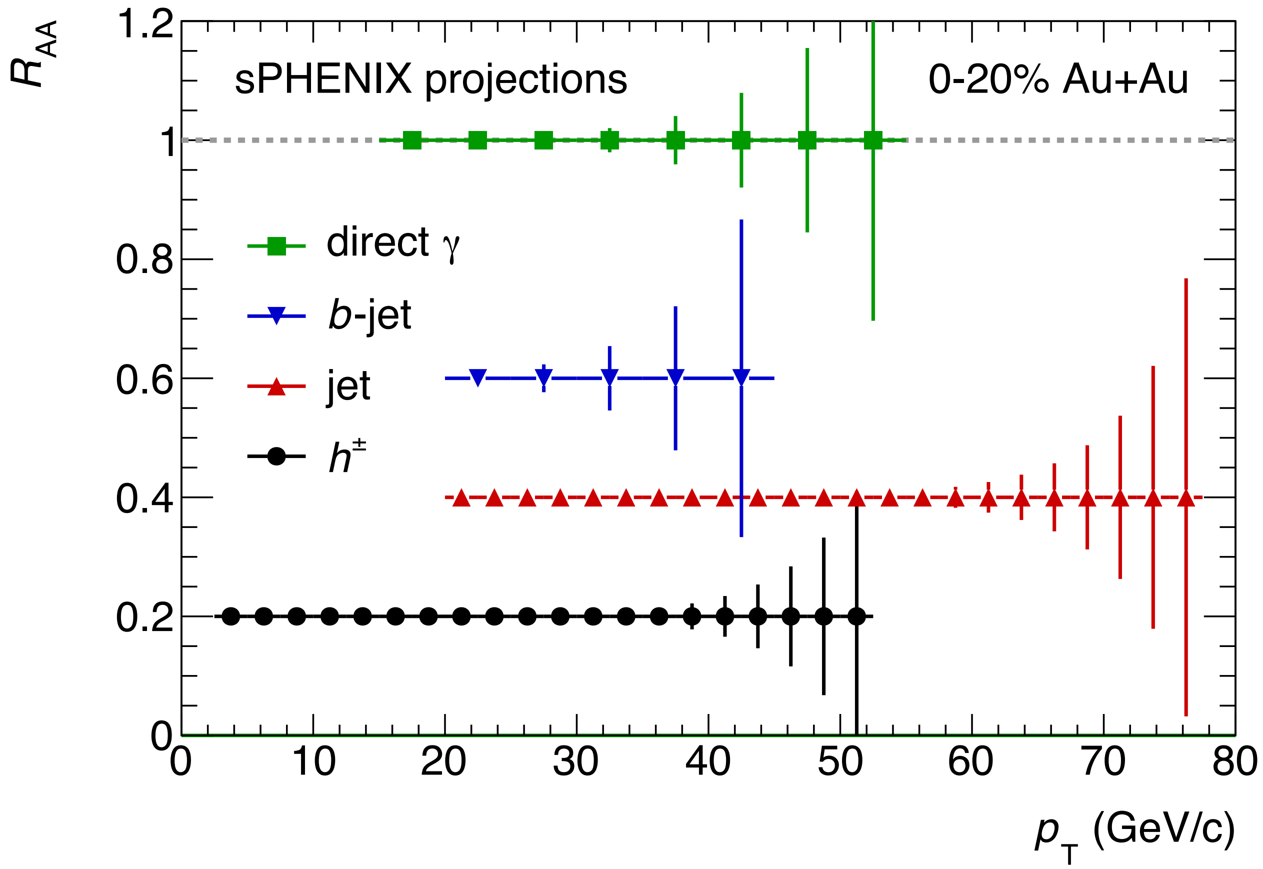
calorimeter observables

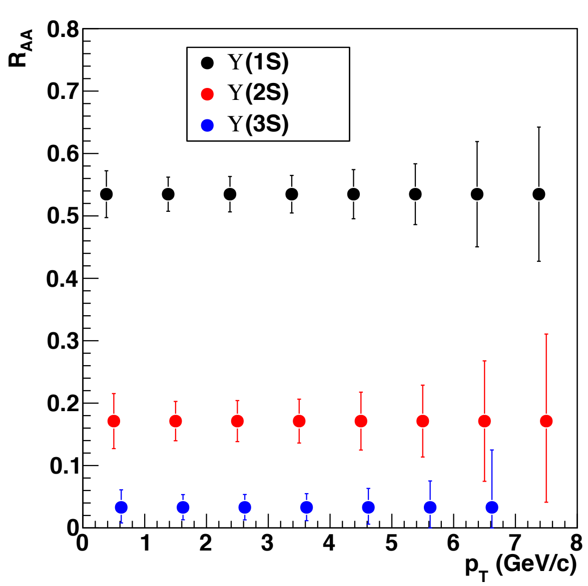
- photons
- upsilons
- jets

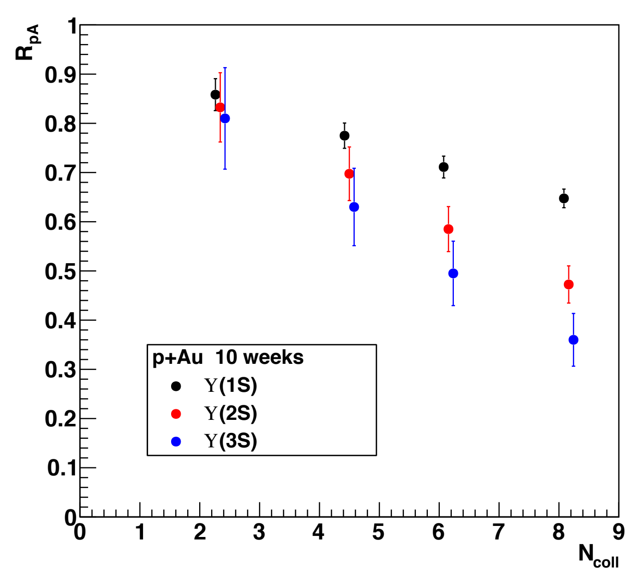


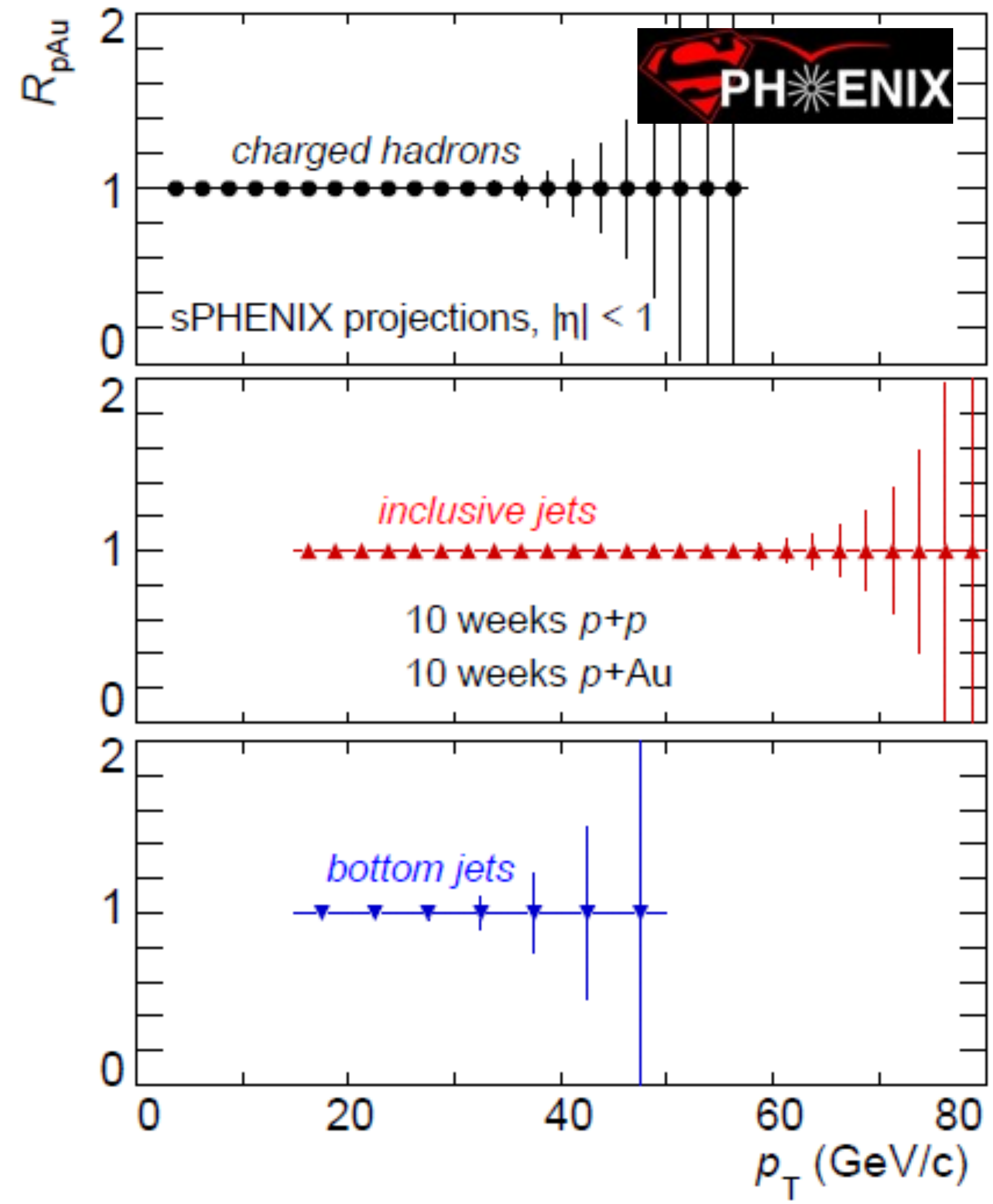
this talk: how does want we want to measure drive the calorimeter system design?

large rates over a wide kinematic range!



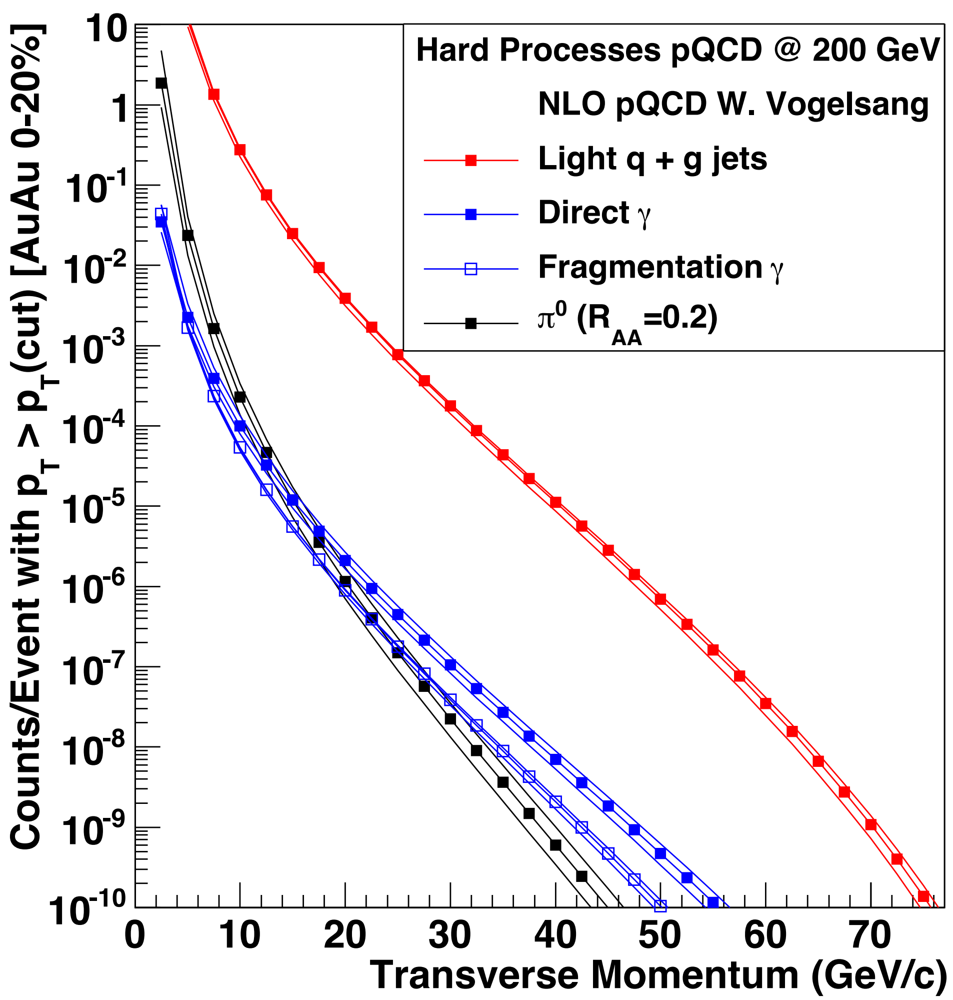


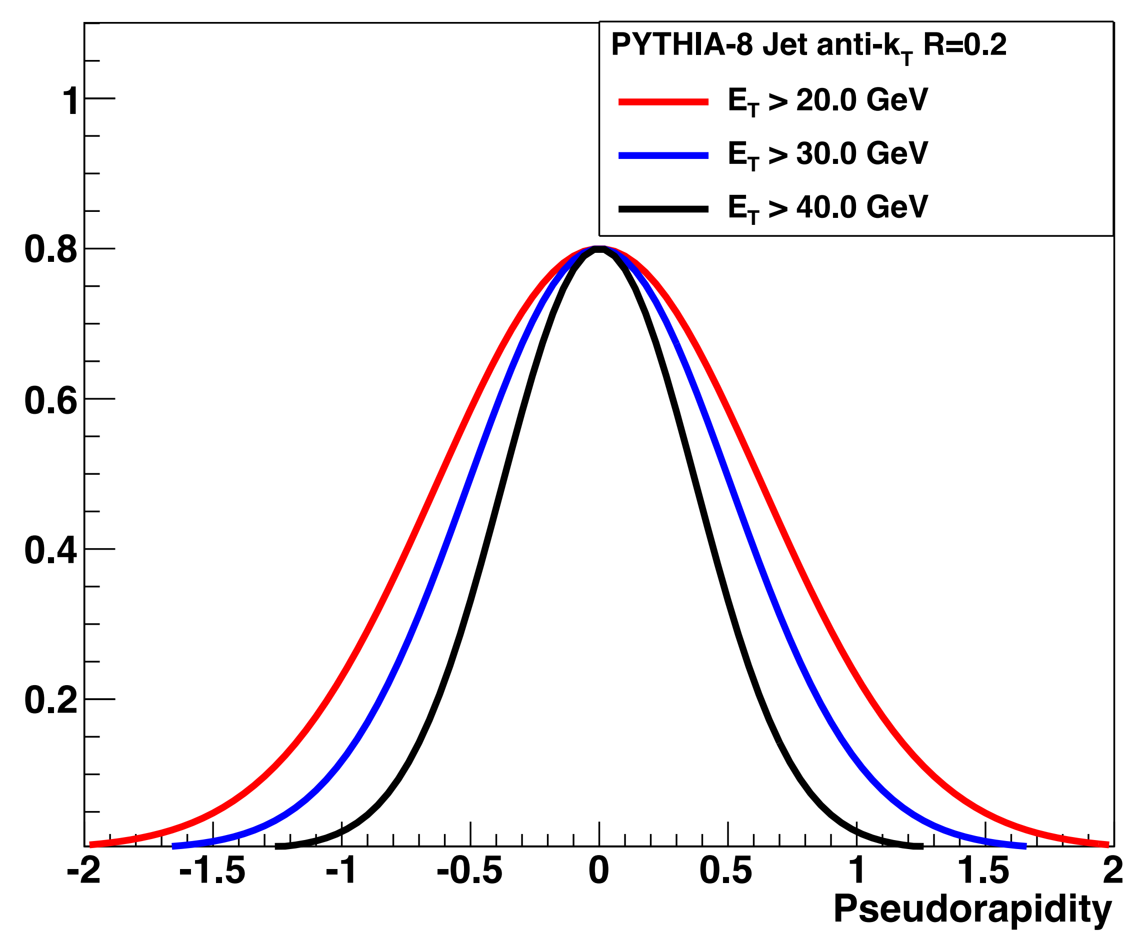




physics requirements

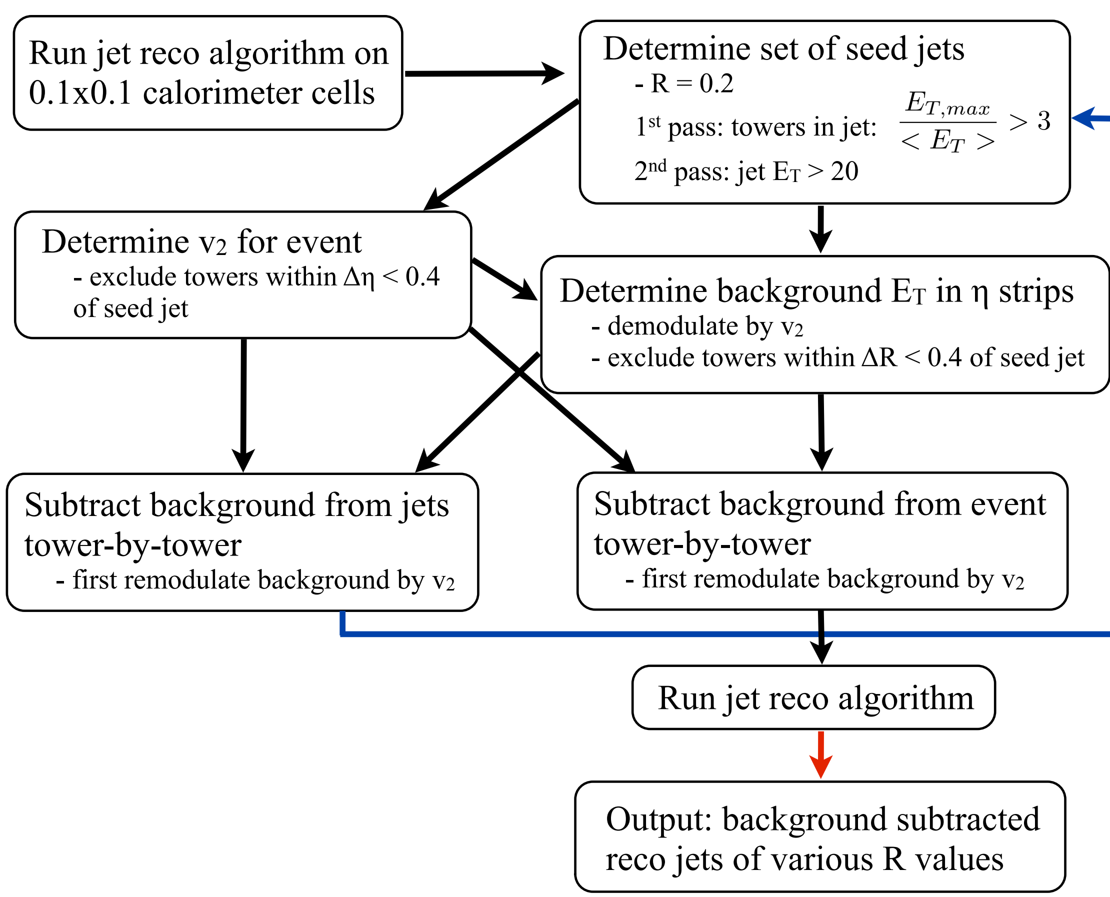
- reconstruction of jets from ~ 20 - 70 GeV
  - EMCal & HCal with full, uniform acceptance over $|\eta| < 1$
    - essential — jets are large objects in the calorimeter
  - ~5.5 λ → 95% energy containment
- good jet performance, both in pp & AA





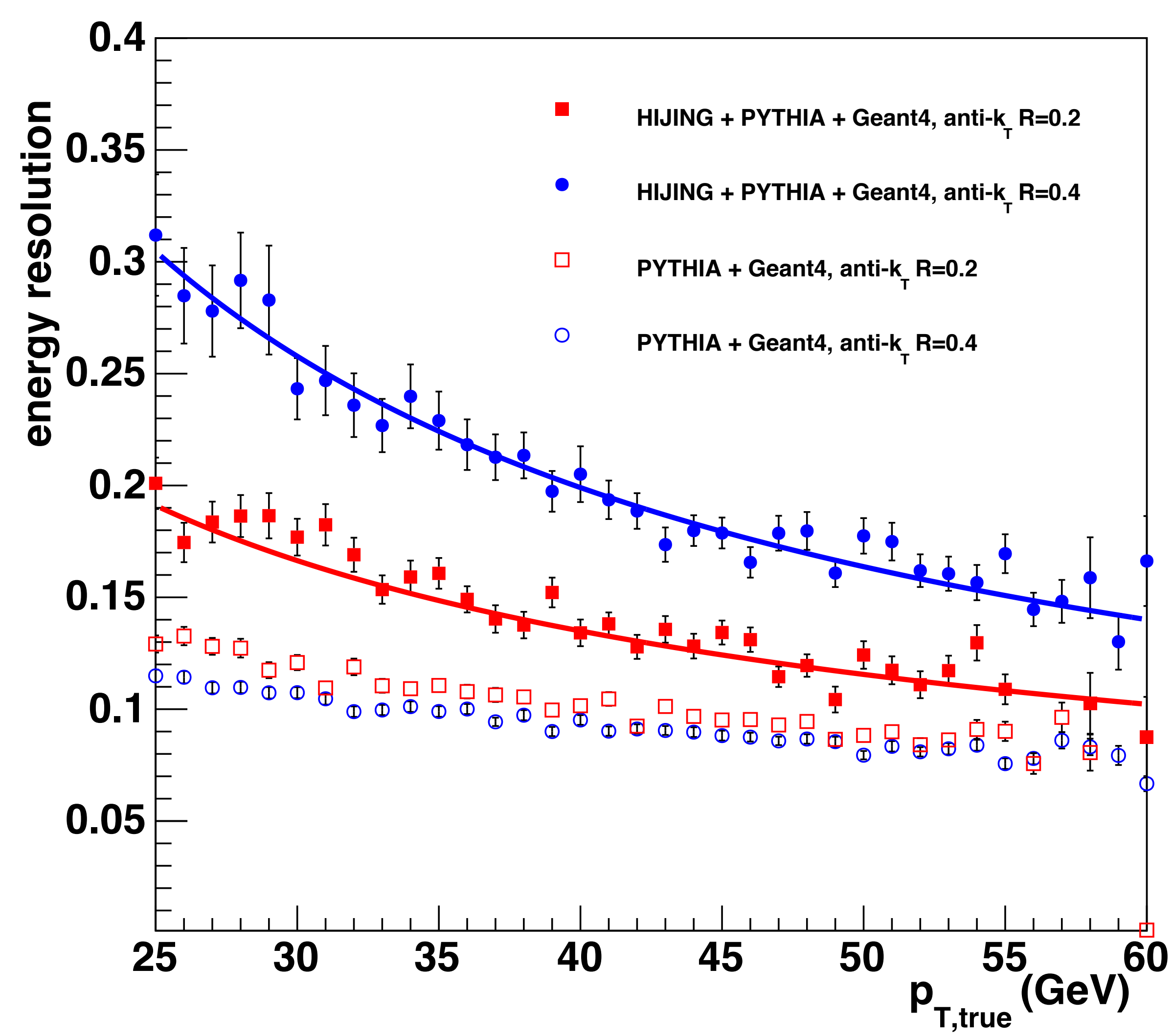
jets in a heavy ion environment

- UE contribution subtracted with ATLAS-style iterative algorithm
- affects of underlying event become more pronounced at low p_T, larger jets and more central events



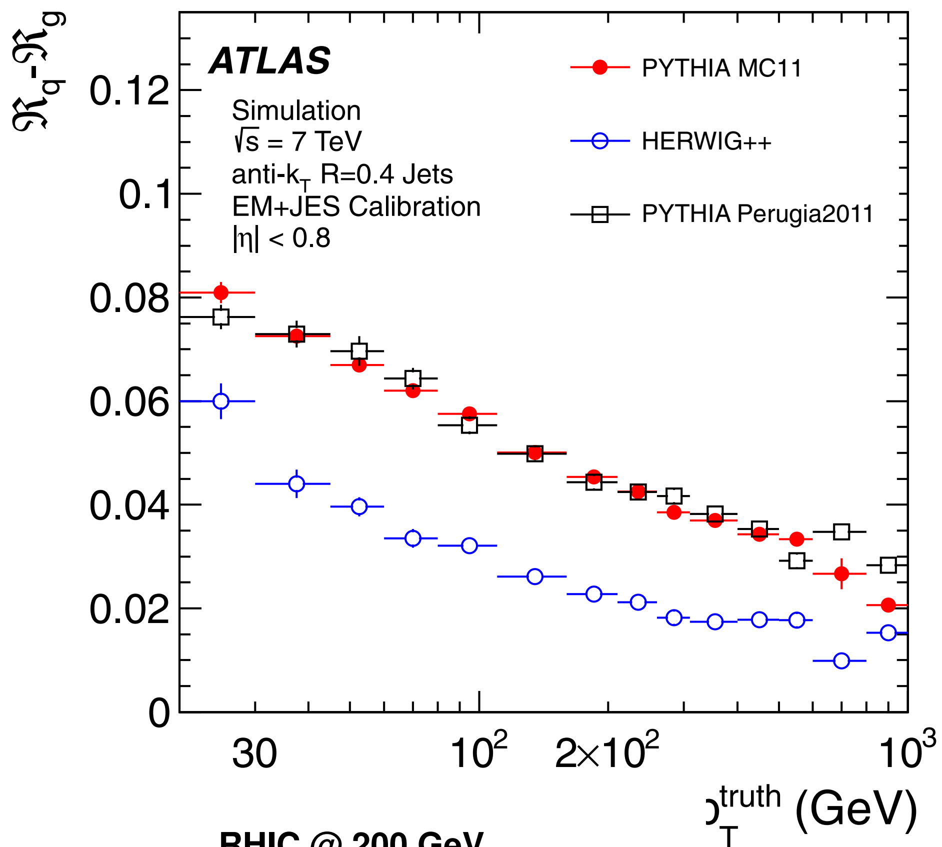
Hanks et al PRC 86 (2012) 024908

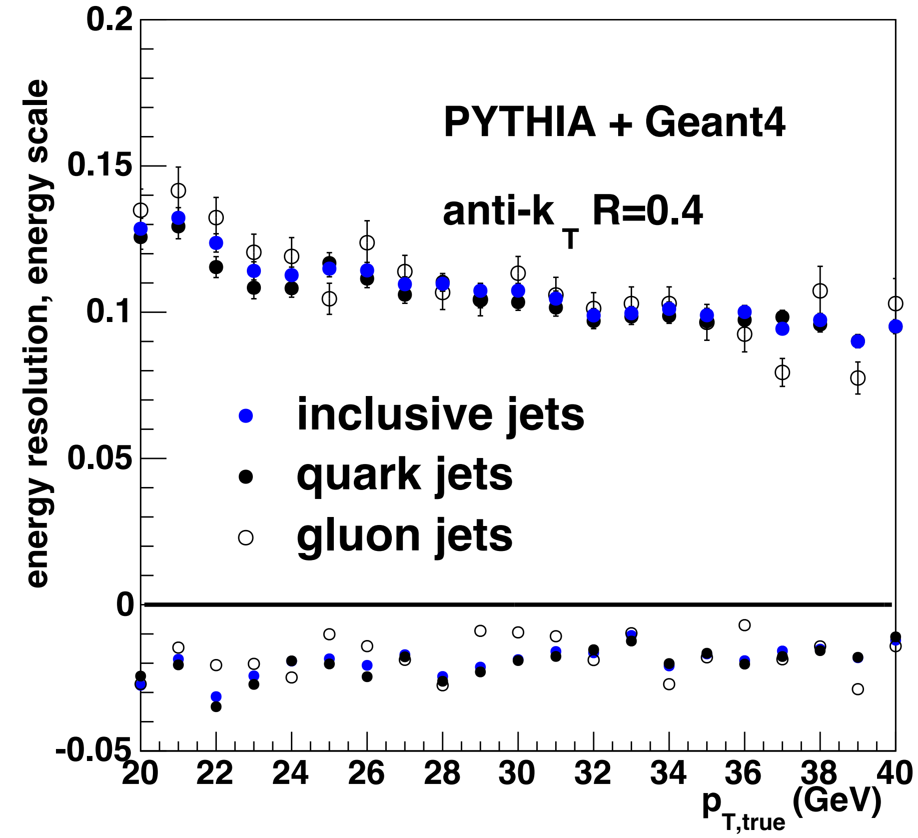
PYTHIA & HIJING in Geant4

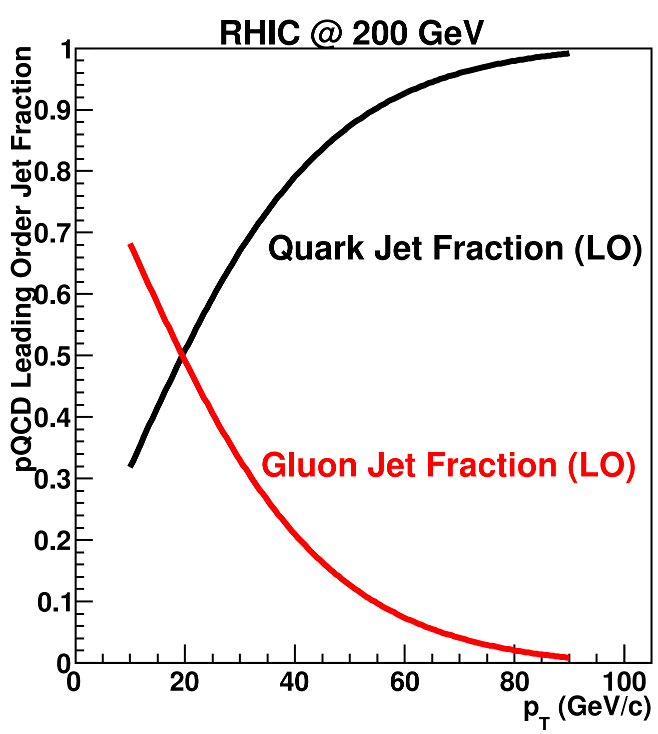


response to modified jets

difference in energy response to
quark and gluon jets



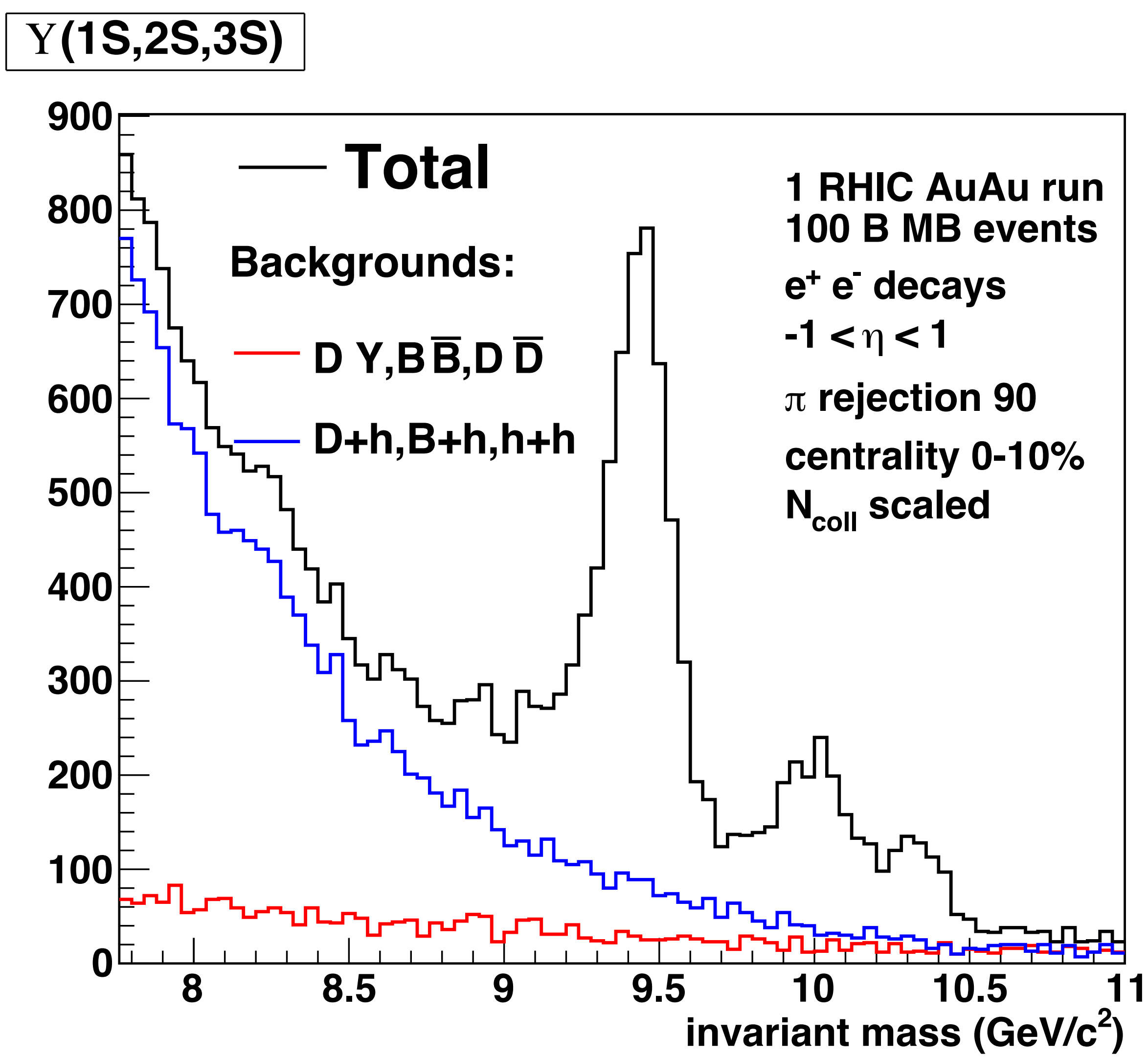


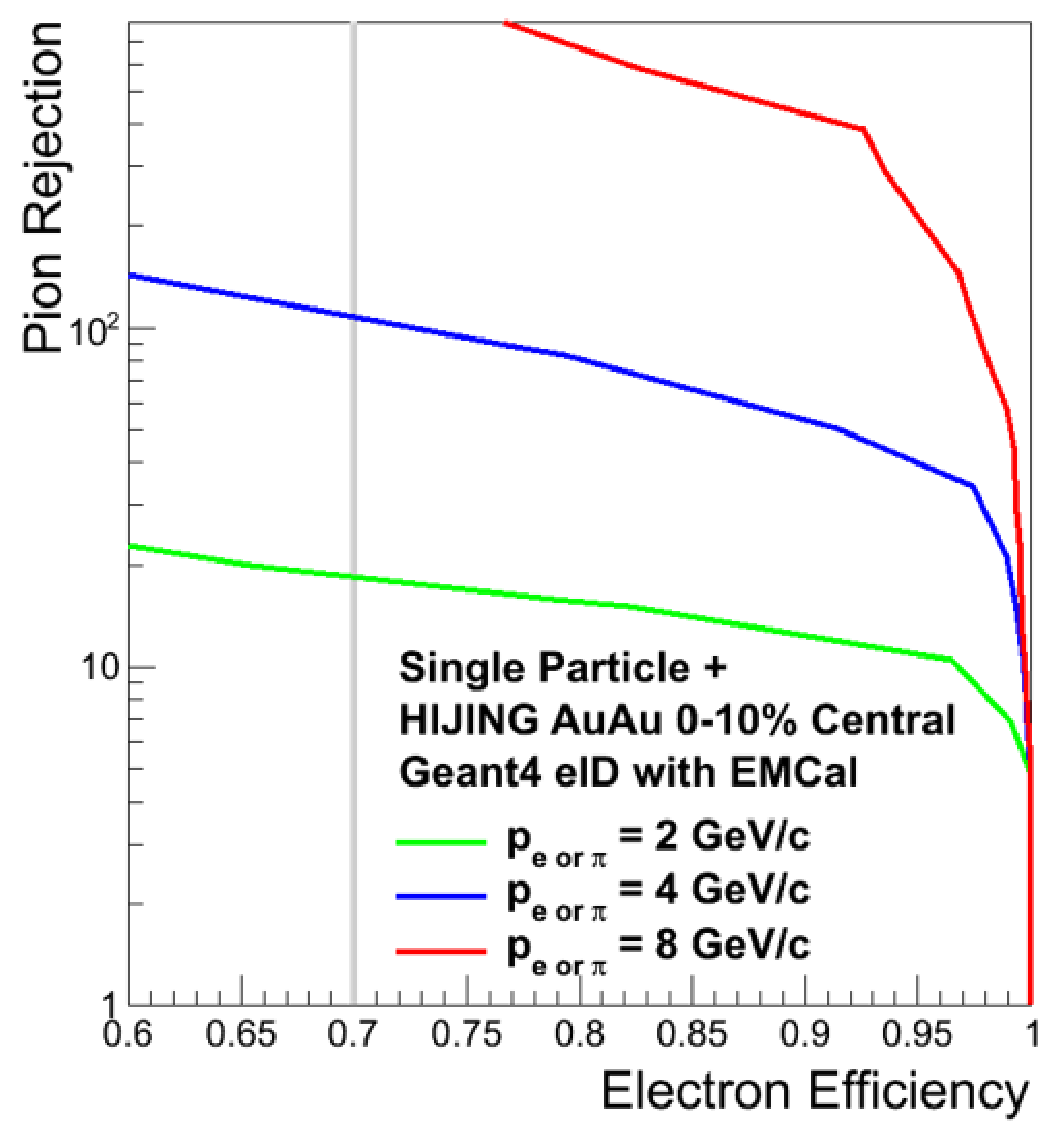


- quark/gluon mix changes quickly at RHIC (also quenching effects)
- good for further study at sPHENIX

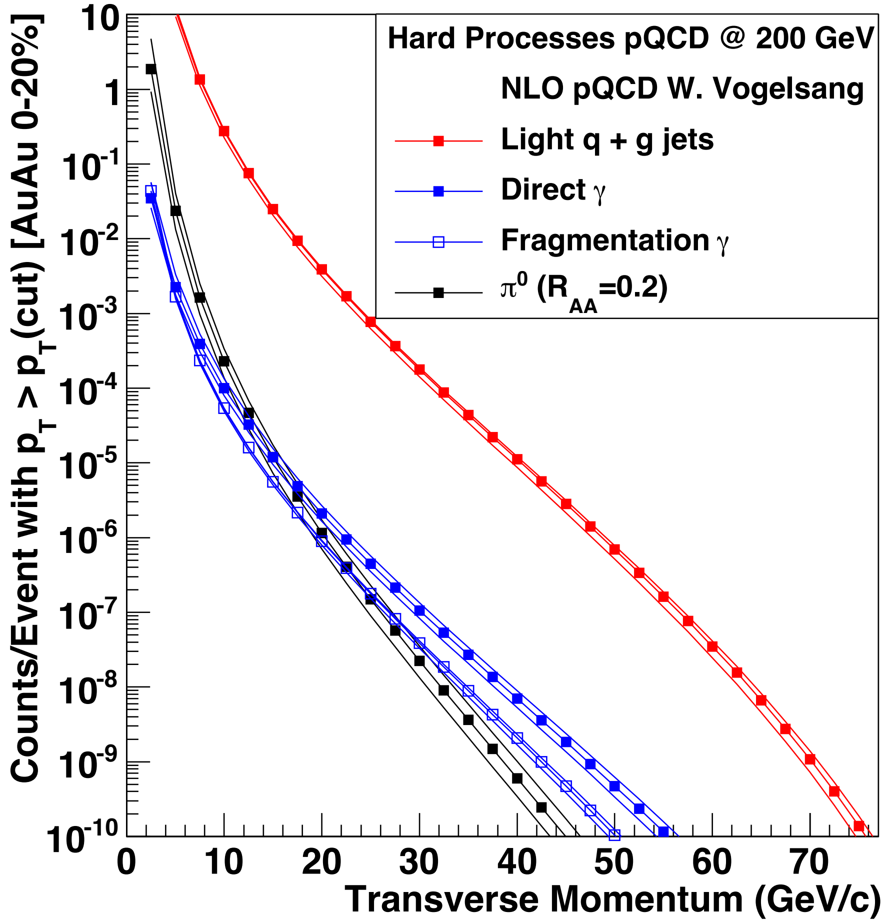
electrons

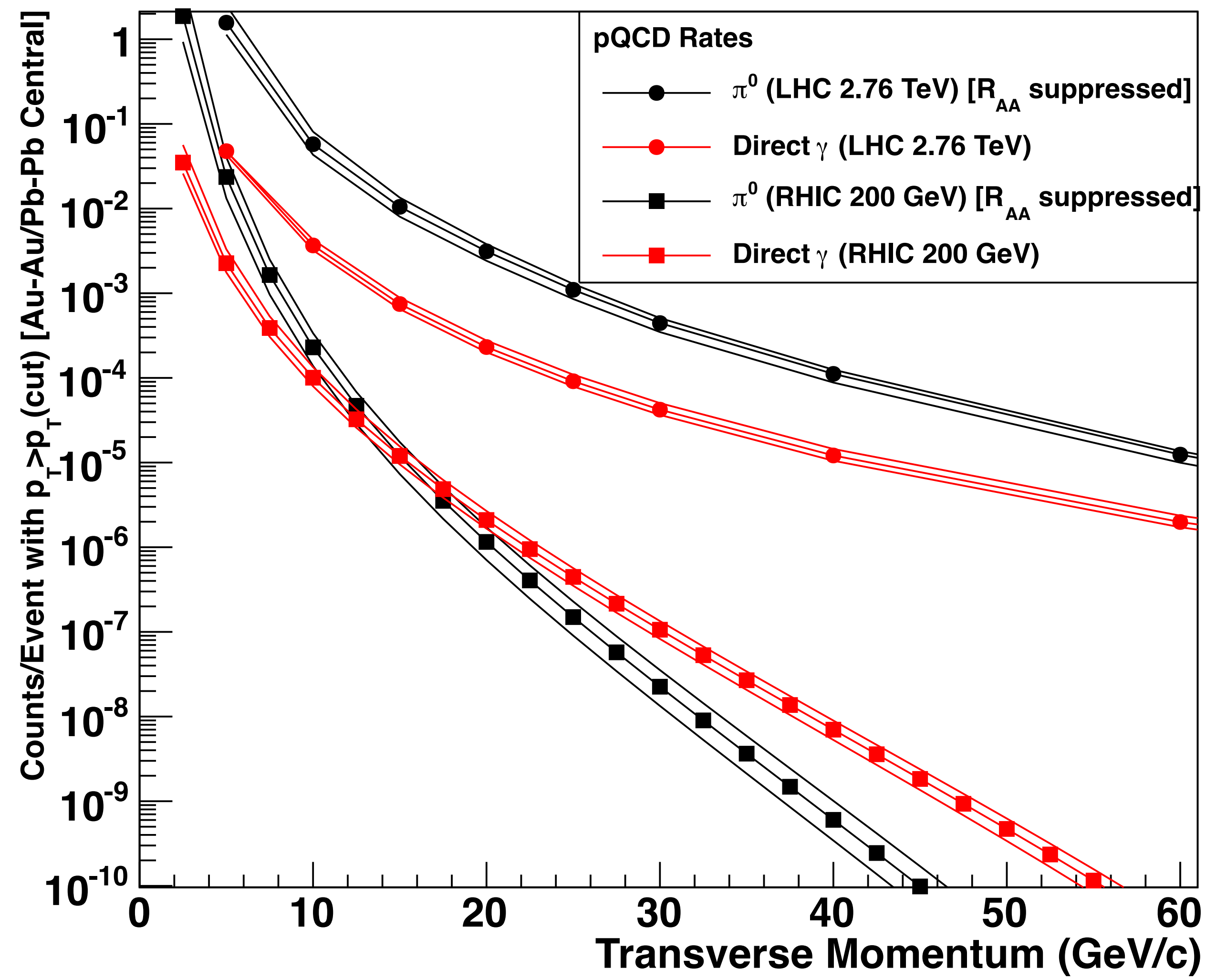
- electron identification: E/p matching
    - necessary to suppress comb. background under Y states





photons

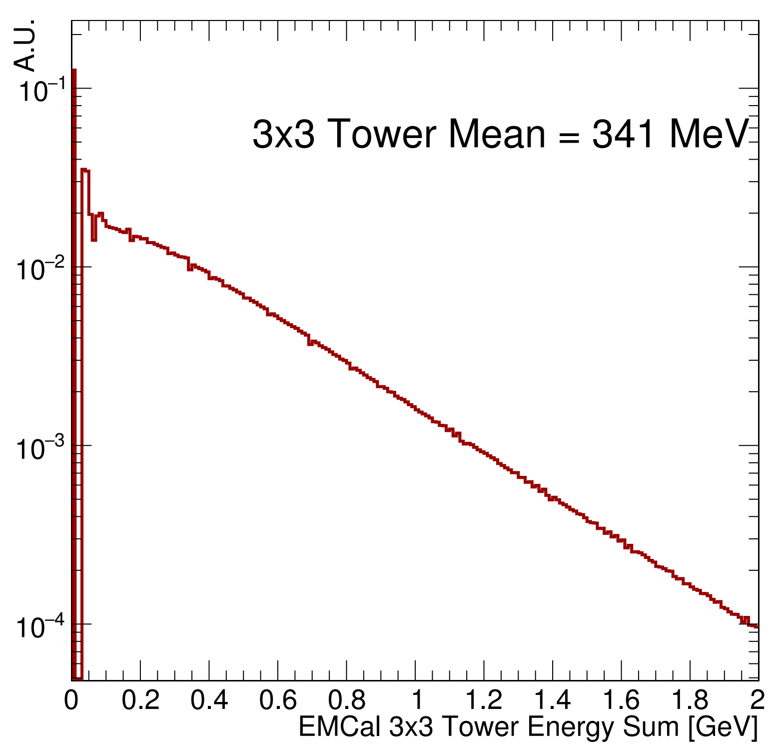




- γ/π^0 ratio > 15 GeV exceeds 1 in AuAu
- γ rates out to ~50 GeV
- segmentation of EMCal needs to be < size of γ clusters

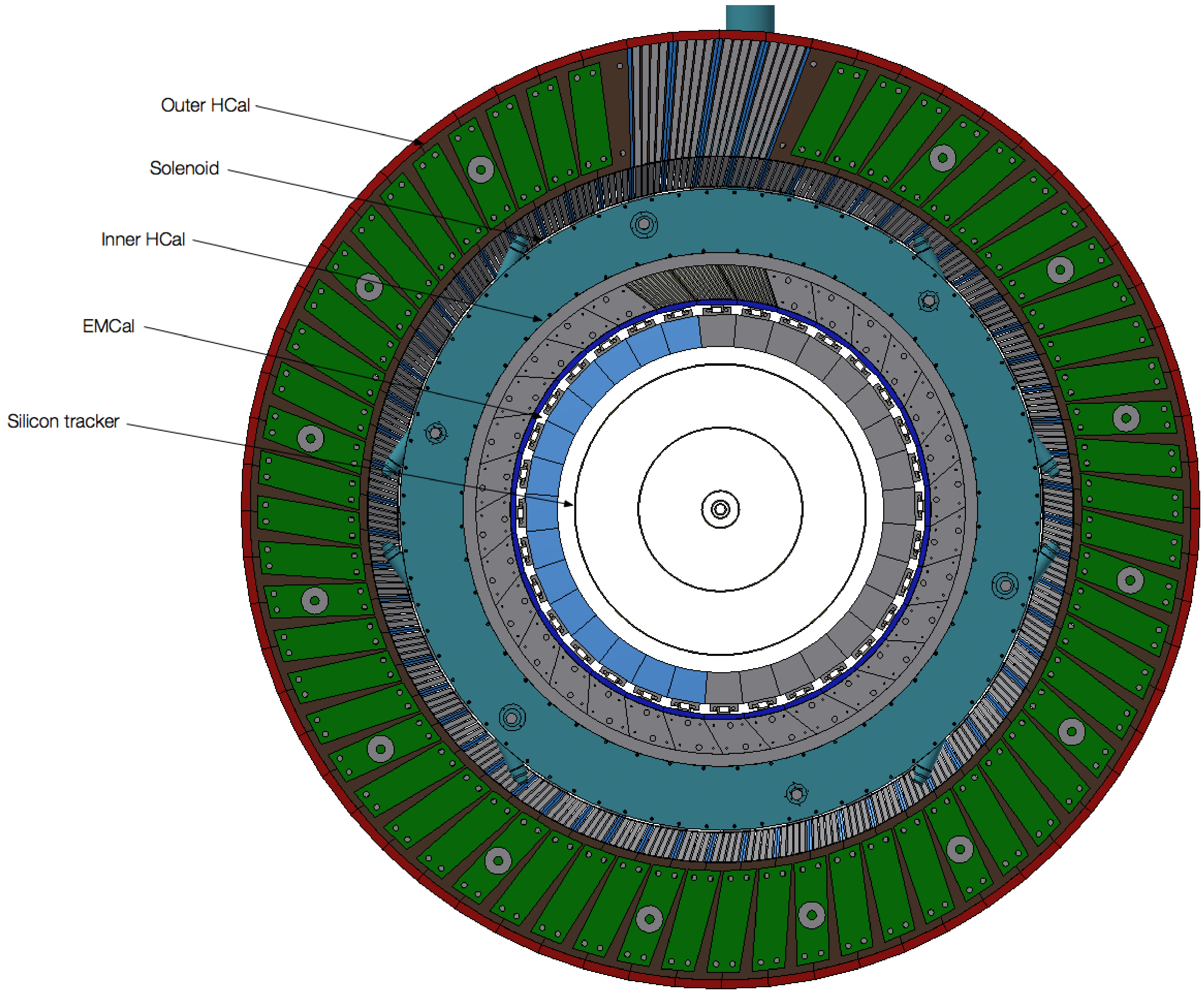
EMCal: energy resolution requirements

- EMCal requirement: distinguish photons & electrons from UE
  - most stringent case: electrons from Υ decay
    - ~5 GeV electrons
    - having the EMCal energy resolution about the same as the UE event contribution under the electron → $\Delta E/E \sim 15\% / \sqrt{E}$
    - inner HCal can provide some help/confirmation



0-10% HIJING @ $\sqrt{s_{NN}}$ = 200 GeV
energy in EMCal in 3x3 tower array

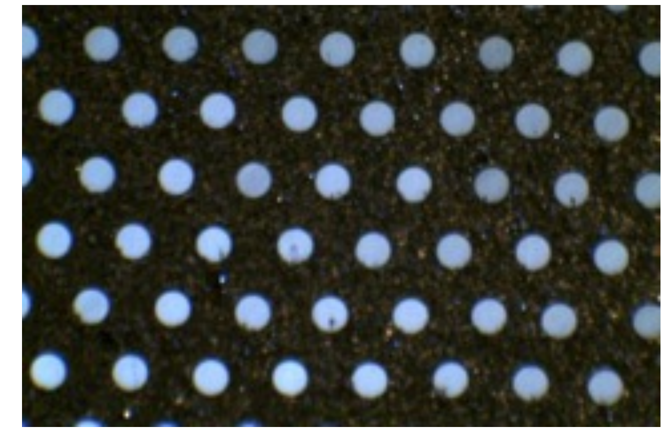
more: J. Huang's talk tomorrow

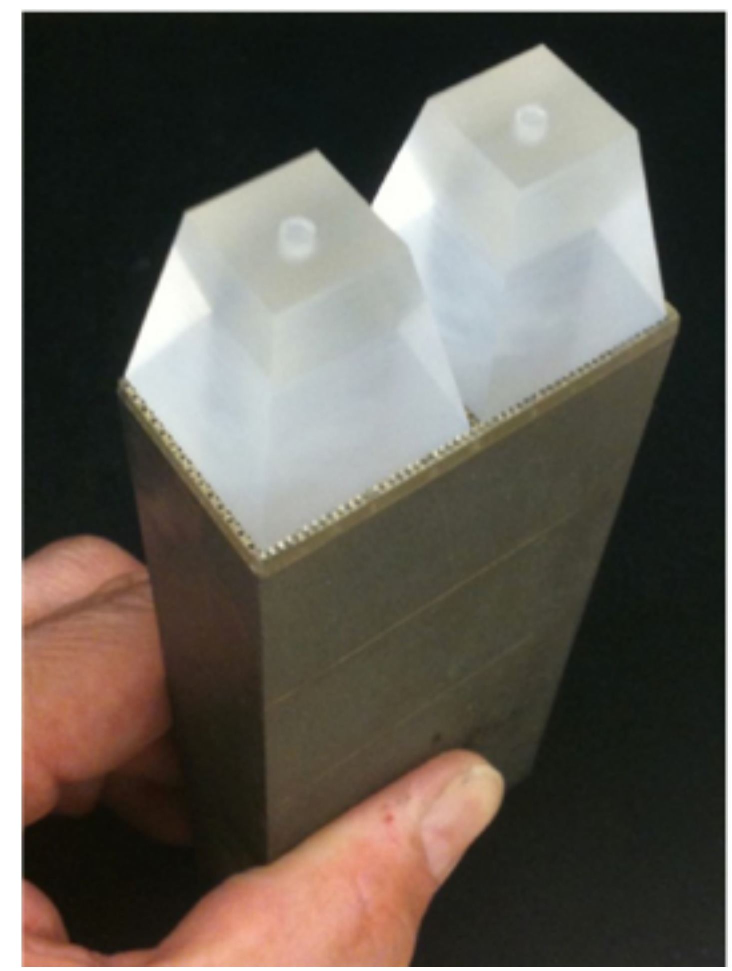


Outer HCal
Solenoid
Inner HCal
EMCal
Silicon tracker

EMCal plan

- tungsten powder / scintillating fiber EMCal
  - 2.3 cm Moliere radius suitable for high multiplicity HI environment at a detector radius of 90cm
- $\Delta\eta \times \Delta\phi$ = 0.024x0.024 = ~25k towers
  - X_0 = 7mm, $18X_0$ = 12cm thick absorber
- provides the necessary 15%/√E energy resolution
- makes good use of the radial space inside the magnet
  - between the tracking and the inner HCal

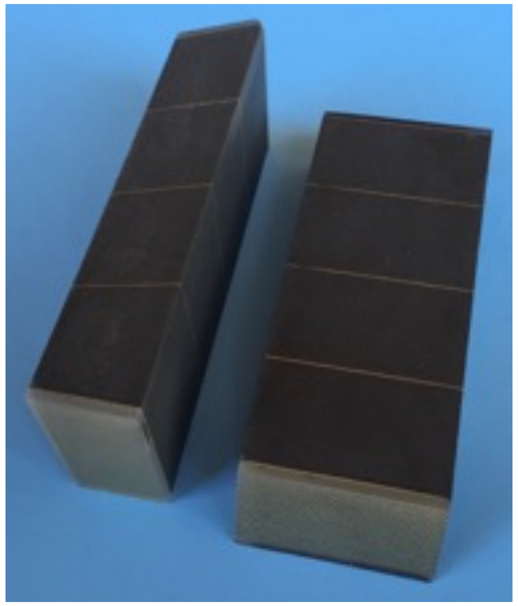


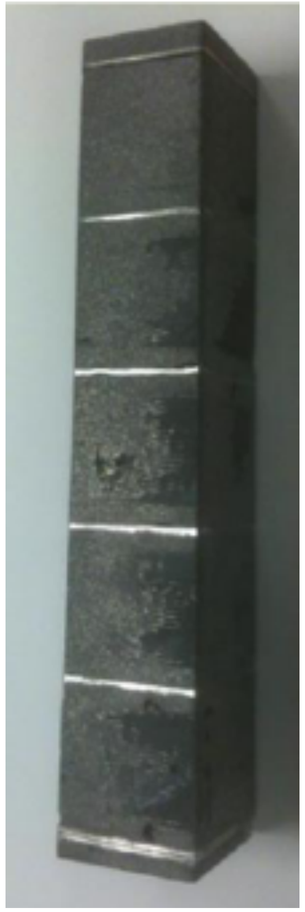


two towers

EMCal plan

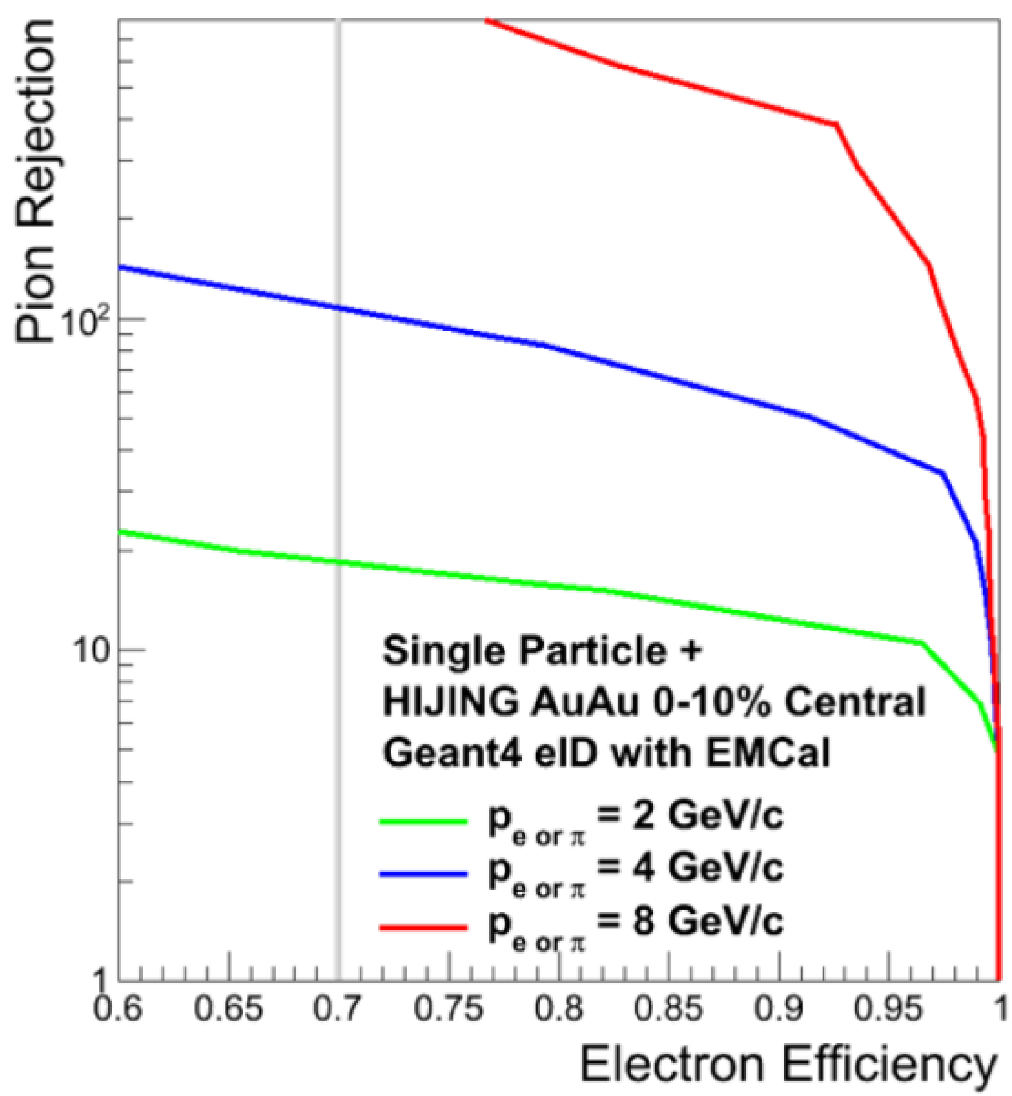
- projective in 2 demensions
  - fibers point back to the IP in ϕ & η
  - 1D projective production under control; 2D projective production process needs development
  - possible we'll only need ϕ projectivity
    - recent improvements to simulations improve e/h separation from initial studies
    - 2D will always have better performance, but production process still under development
- **1D/2D projectivity is a major decision point in the EMCal design**



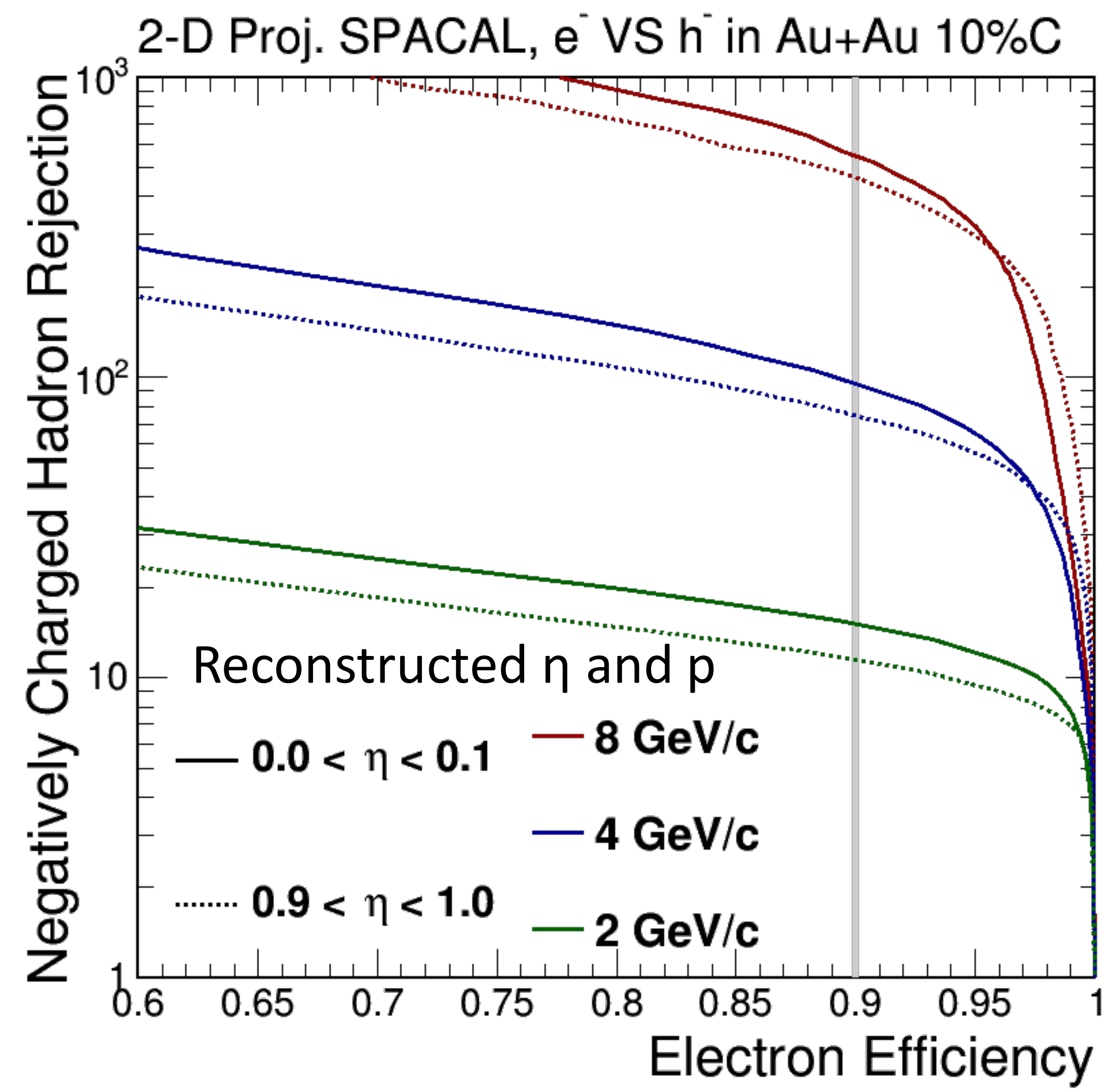


electron ID performance

pCDR AuAu simulations

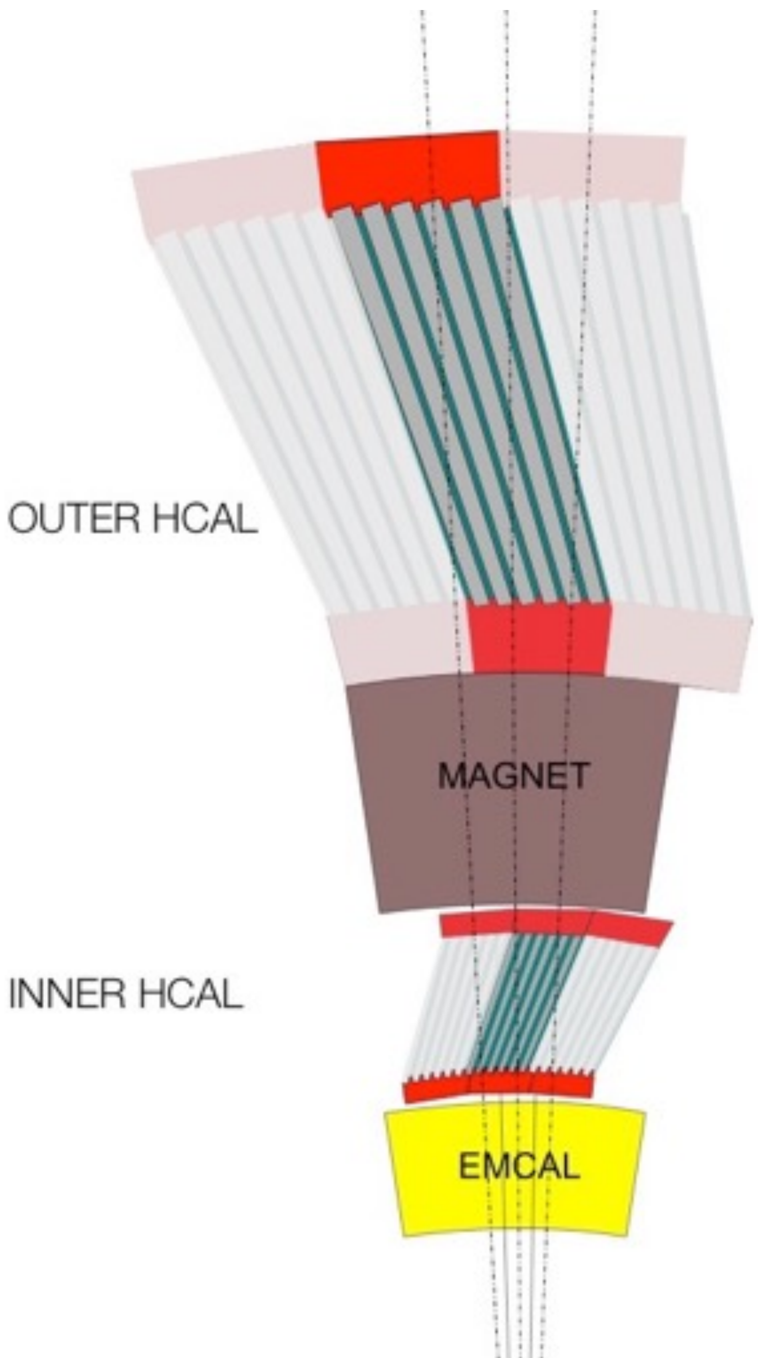


updated AuAu simulations

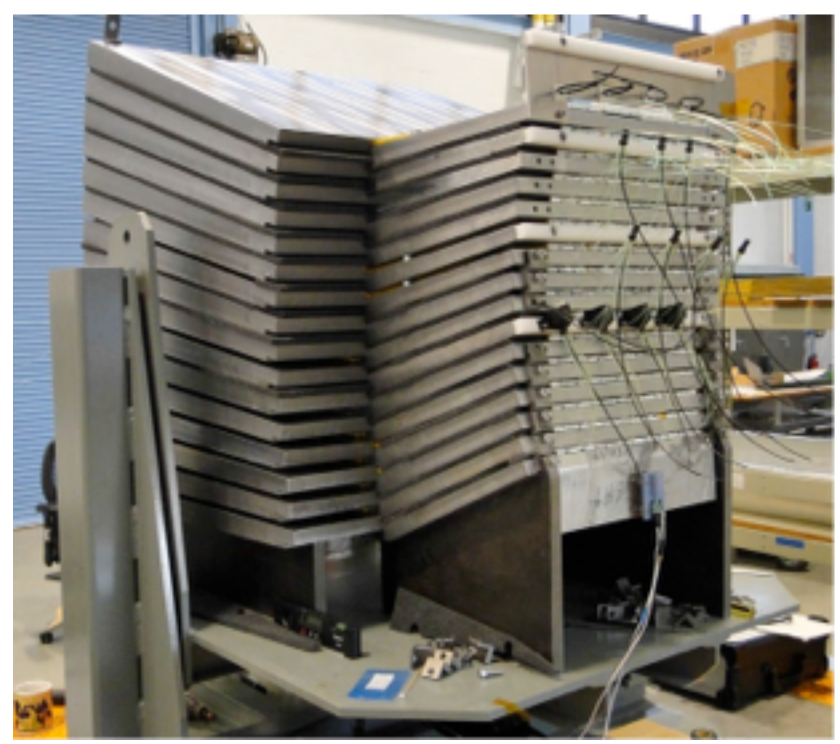


physics requirement: 90:1 rejection at 70% electron efficiency, updated simulations provide some additional safety margin/higher electron efficiency

HCal concept

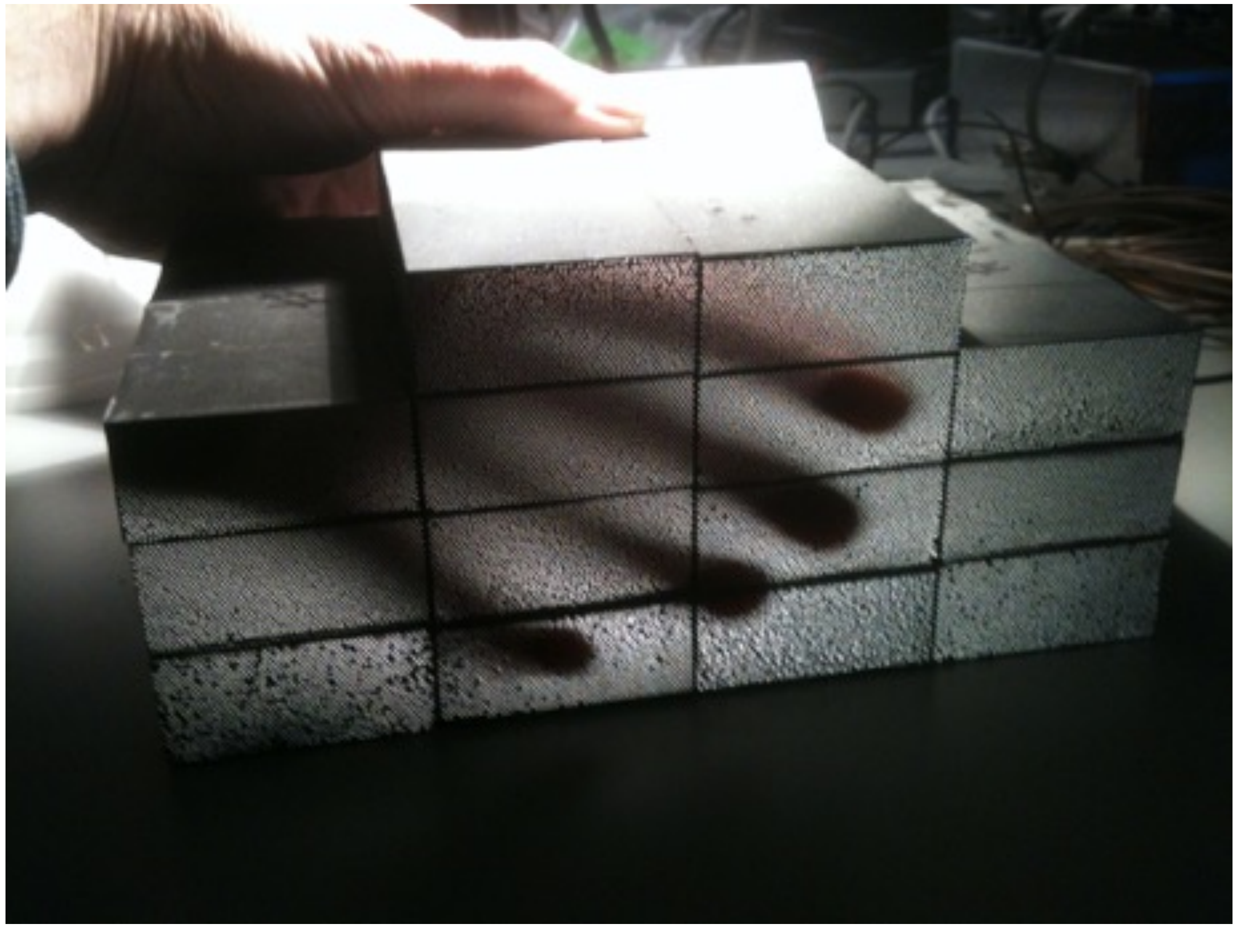


- two sections
  - 1λ between the EMCal and magnet
  - 3.5λ after magnet
- ΔηxΔϕ = 0.1x0.1
  - hadronic showers large
- steel absorber plates with scintillating tiles



2014 prototype

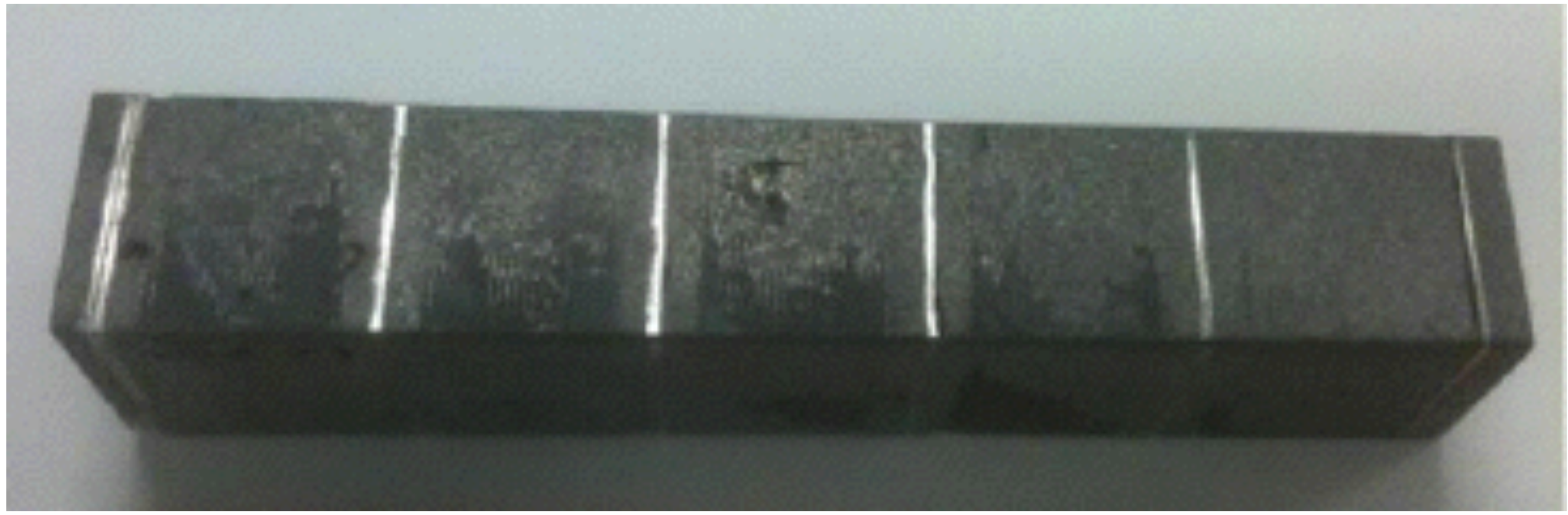
moving forward



stacking Illinois produced modules at BNL last week!

- prototyping: April 2016 at Fermilab
  - targeted toward $\eta = 0$
    - EMCal modules 1D projective
    - modules produced at Illinois & THP (outside company)

moving forward



- prototyping: November 2016 @ Fermilab
  - targeted toward high |η|
    - EMCal: decision point for 1D vs 2D projectivity
    - need to know if we can build it
    - need to know if we need it—simulations

moving forward

- great progress on electron identification targeted simulations
- over the next several months need to decide on 1D vs 2D projectivity for the EMCal
    - manpower challenge since it's in parallel with testbeam at Fermilab
- simulations: validate them with testbeam at Fermilab and update the physics performance of the calorimeters

summary

- many details I've left out
  - more dedicated talks tomorrow
  - EMCal (Craig Woody)
  - HCal (John Lajoie)
  - Electronics (Eric Mannel)
  - Simulations (Jin Huang)

we've made a lot of progress, but there are lots of ways remaining to contribute to calorimeters and their simulations, come talk to us!